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Wells et al.

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[54] **METHOD AND APPARATUS FOR PROTECTING AN INJECTION DEVICE DISPOSED IN A HOT BLAST CONDUIT OF A BLAST FURNACE**

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[51] **Int. Cl.**[6] **C21B 7/16**

[52] **U.S. Cl.** **75/460**; 266/46; 266/189; 266/270; 75/465

[58] **Field of Search** 75/460, 461, 465; 266/189, 270, 222, 268

[56] **References Cited**

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OTHER PUBLICATIONS

"Investigation Pulverized Coal Injection with Oxygen at NKK", Steel Times, Feb. 1990, pp. 83–865.

Primary Examiner—Melvyn J. Andrews
Attorney, Agent, or Firm—Lahive & Cockfield

[57] **ABSTRACT**

To prevent burn-back at a coal dust injection lance which projects into a hot blast conduit of a blast furnace, cooling is effected using atomized coolant. Water is preferred as the coolant. The carrier gas used for the atomized water is either air or the oxygen which is injected through the lance for complete combustion of the coal dust.

11 Claims, 3 Drawing Sheets

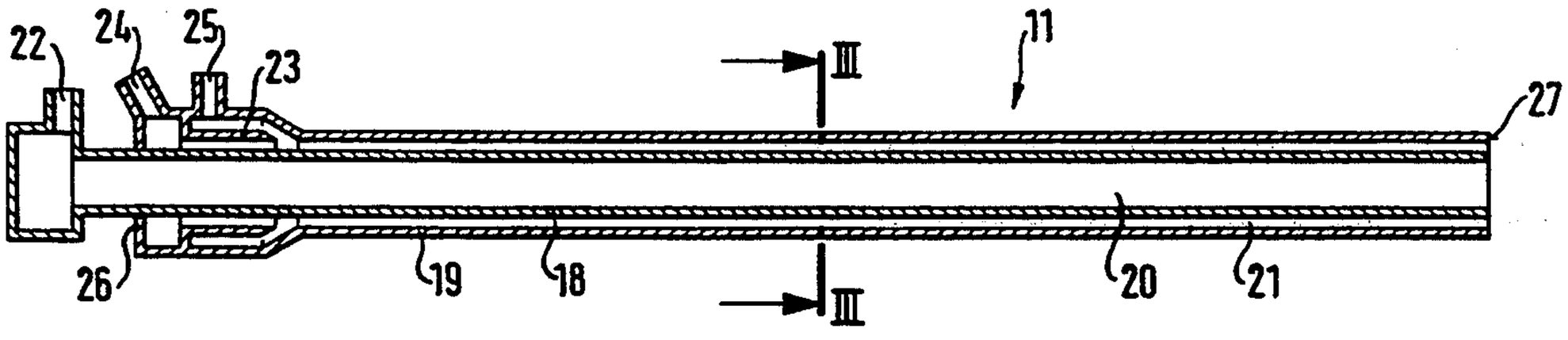


Fig. 1

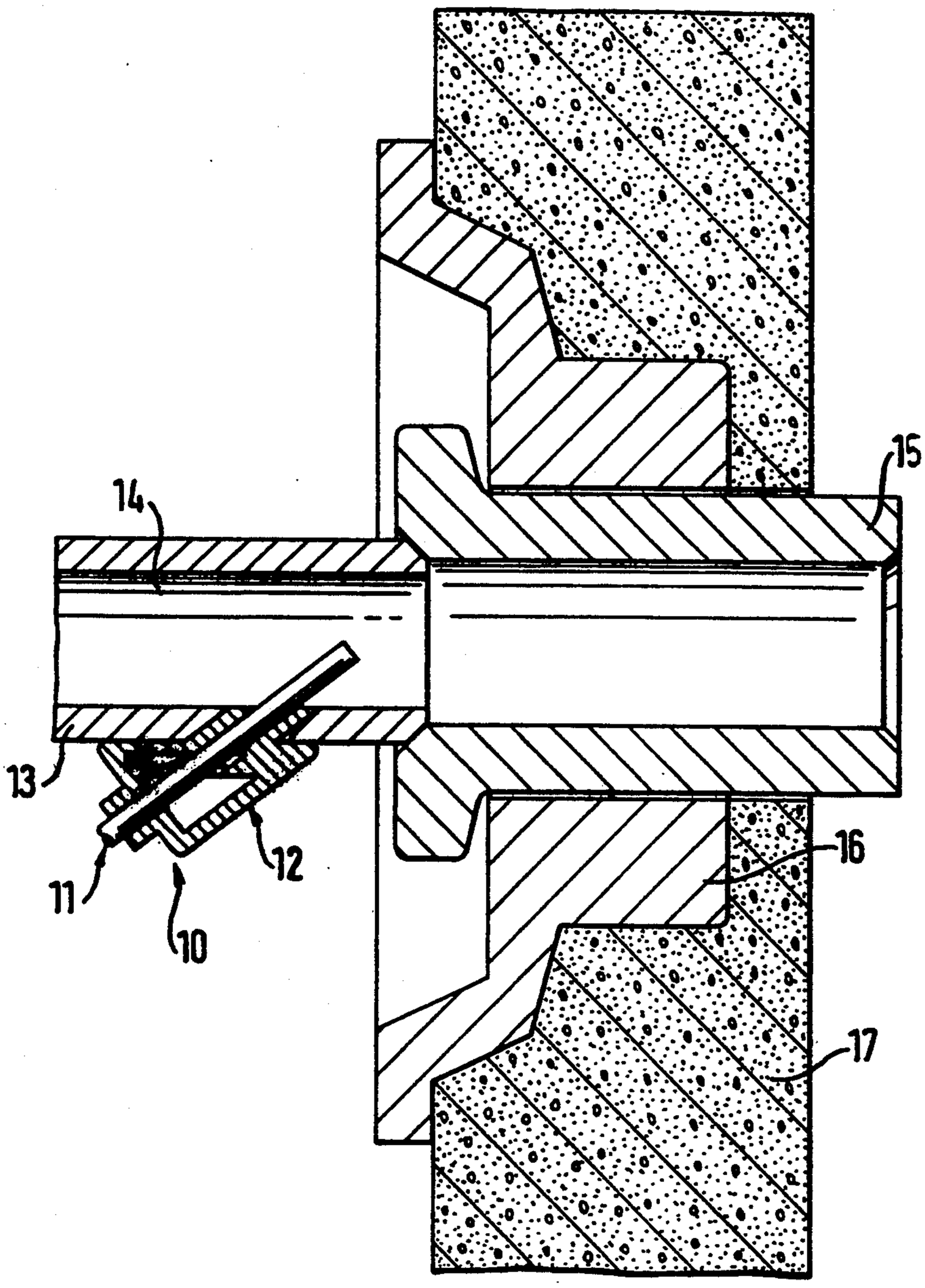


Fig. 2

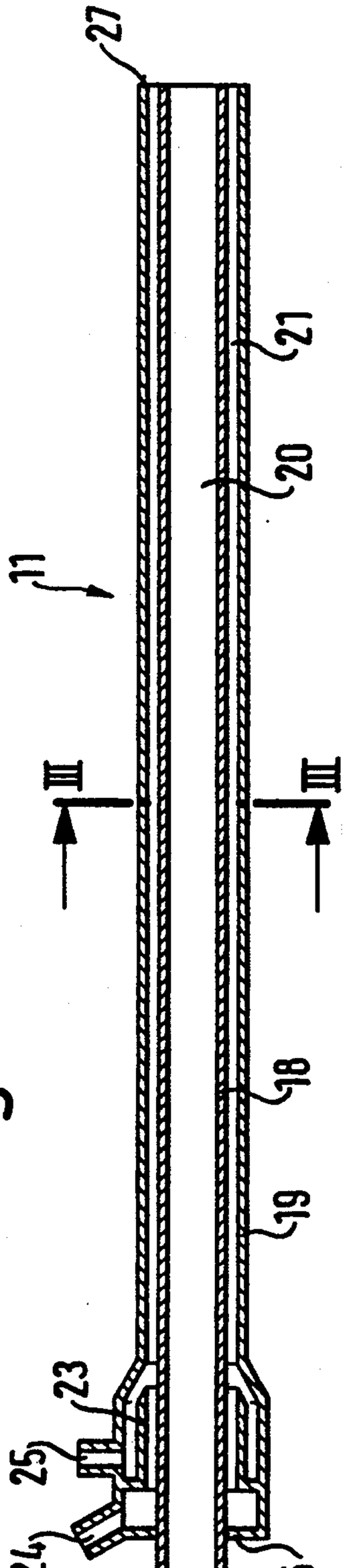


Fig. 3

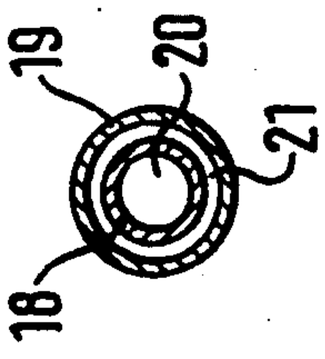


Fig. 4

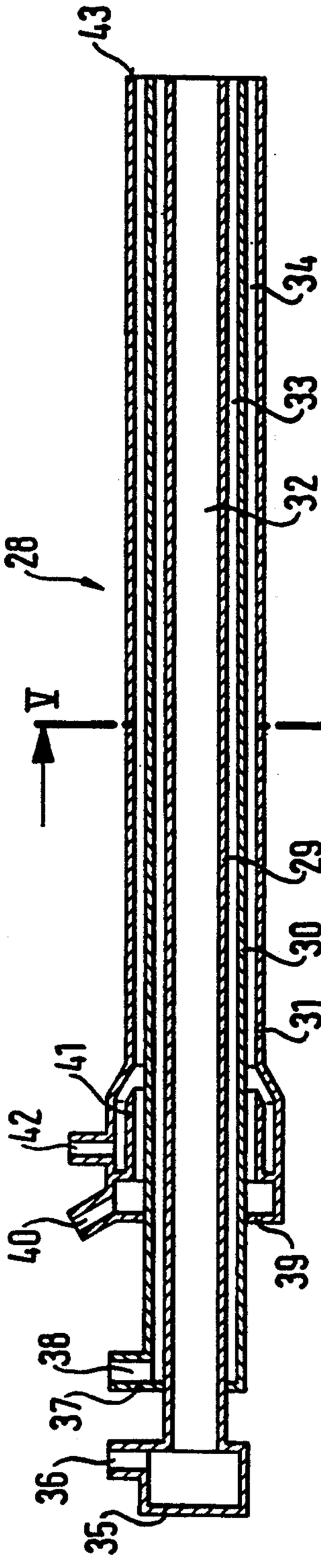


Fig. 5

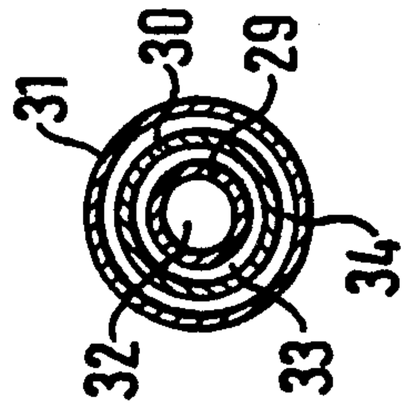
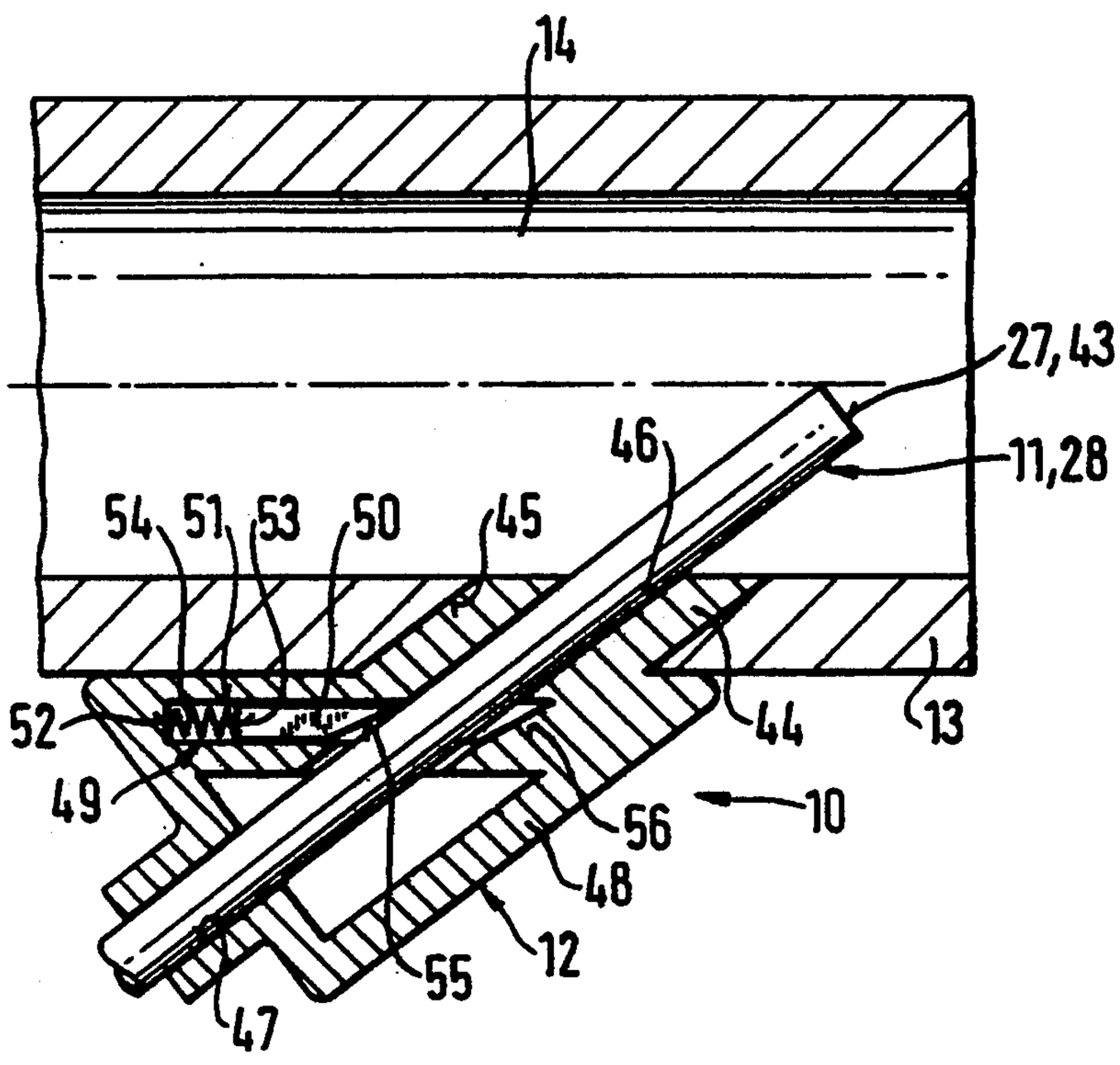


Fig. 6



METHOD AND APPARATUS FOR PROTECTING AN INJECTION DEVICE DISPOSED IN A HOT BLAST CONDUIT OF A BLAST FURNACE

BACKGROUND OF THE INVENTION

The invention concerns a method and an apparatus for protecting an injection device in a blast furnace. Specifically, the invention is directed to a method and apparatus for cooling the injection lance disposed in the hot blast conduit.

Injection lances for injection coal dust as a substitute fuel, for example for piece coke and heating oil, into the hot blast conduit of a blast furnace by means of a carrier gas, have long been used in the smelting of iron ores (Stahl und Eisen 110, 1990, pages 35–40). In recent times endeavours have been made to increase the maximum amounts of coal dust which hitherto could be injected by the injection of oxygen or an oxygen-bearing gas together with the coal dust which is entrained by a carrier gas.

In conjunction with the hot blast temperature which is about 1200° C., that results in a strong tendency to burn back in the mouth region of the injection lance.

U.S. Pat. No. 3,758,090 discloses an arrangement with which an injection lance for injecting fuel, which is fitted into the hot blast conduit of a blast furnace, can be cooled. The known injection lance comprises a central tube which serves for the supply of heating oil. The central tube is concentrically surrounded by a multi-wall outer tube in which oxygen is supplied; the oxygen serves for atomisation and combustion of the heating oil which issues from the central tube. For cooling purposes, the outer tube has a coolant duct which permits a circulation of coolant in the outer tube, by way of a feed connection and a discharge connection.

The object of the present invention is that of providing a method and an apparatus which provides improved cooling of the injection lance, which reduces the burn-back phenomenon.

SUMMARY OF THE INVENTION

In a two-tube lance, the coal dust is injected through the central duct and a mixture of oxygen-bearing gas and the cooling fluid is injected through an annular duct which surrounds the central duct.

In a three-tube lance, coal dust is injected through the central duct, oxygen-bearing gas is injected through the inner annular duct and the cooling fluid is injected through the outer annular duct. This permits mutually independent control of the pressures of the oxygen-bearing gas and the cooling fluid.

It is found to be particularly advantageous if the cooling fluid used is water which is injected in the form of a spray mist in an atomised condition, by means of a carrier gas. As a result of atomisation of the water, microdrops are formed, which are at least partly in contact with the tube wall to be cooled and which by virtue of their enthalpy of evaporation, make a particularly effective contribution to the overall cooling action which in other respects is achieved by a transfer of heat from the tube wall to the cooling fluid which is formed from the water and the carrier gas and which flows past the tube wall.

Further advantageous configurations of the injection are set forth in the description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the invention are described in greater detail with reference to the accompanying drawings in which:

FIG. **1** shows an injection apparatus according to the invention, which is fitted into a hot blast conduit of a blast furnace,

FIG. **2** is a view in longitudinal section of an injection lance of an injection apparatus which is fitted into a hot blast conduit of a blast furnace, as shown in FIG. **1**,

FIG. **3** is a view of the injection lance of FIG. **2** in cross-section taken along section line III—III in FIG. **2**,

FIG. **4** is a view in longitudinal section of a further embodiment of an injection lance,

FIG. **5** is a view of the injection lance shown in FIG. **4** in cross-section taken along section line V—V in FIG. **4**, and

FIG. **6** shows an injection apparatus fitted into the hot blast conduit of a blast furnace as shown in FIG. **1**, with an injection lance accommodated in a receiving arrangement.

DETAILED DESCRIPTION

FIG. **1** shows an injection apparatus **10** comprising an injection lance **11** and a receiving arrangement **12** for accommodating the injection lance **11** in an outside wall **13** of a hot blast conduit **14**.

The hot blast conduit **14** serves for feeding hot air at about 1200° C. into the interior of a blast furnace (not shown here). The hot blast conduit **14** opens into a water-cooled tuyere **15** which is accommodated by a water-cooled tuyere insert **16**. The tuyere insert **16** is fitted into a wall **17** of the blast furnace.

The injection apparatus **10** serves for the injection of coal dust into the hot blast conduit **14** of the blast furnace. The coal dust which issues from the injection lance **11** into the hot blast is heated by the hot blast and is ignited at the latest upon passing into the blast furnace.

FIGS. **2** and **3** show a first embodiment of the injection lance **11**. It comprises a central inner tube **18** and an outer tube **19** which is arranged in concentric relationship with the inner tube **18**. The inner tube **18** forms a central duct **20** and the outer tube **19**, by virtue of its radial spacing relative to the inner tube **18**, forms an annular duct **21** (see FIG. **3**). The inner tube **18** is provided with an inlet **22** for the supply of a mixture comprising a carrier gas and coal dust. The outer tube **19** has two inlets **24** and **25** which are separated from each other by a separating wall or partition **23**. The inlet **24** which is towards a closed end **26** of the tube serves for the supply of water and the adjacent inlet **25** serves for the supply of oxygen.

The injection lance **11** shown in FIGS. **2** and **3** can be used for carrying out the per se known method of injecting coal dust through the central inner tube **18** by means of a carrier gas and supplying oxygen through the annular duct **21** for better combustion of the coal dust.

Now, in accordance with the method of the invention, water is added through the inlet **24** to the oxygen which is carried in the annular duct **21** so that the water is entrained by the oxygen which flows past the separating wall **23** and is atomised, forming fine microdrops. The spray mist of oxygen and water which is formed in that way serves both for combustion of the coal dust issuing from the duct **20** and also for cooling of the

walls of the inner tube **18** and the outer tube **19** including the discharge cross-section **27** of the injection lance **11**, which, as shown in FIG. **1**, is exposed to the hot blast flow in the hot blast conduit **14**.

In the described variant of the method according to the invention therefore, the oxygen serves not only for better combustion of the coal dust but also as a carrier gas for the atomised water.

FIGS. **4** and **5** show an injection lance for carrying out a further alternative form of the method according to the invention. The injection lance **28** comprises a central inner tube **29**, a central tube **30** and an outer tube **31**. The inner tube **29** and the central tube **30** as well as the outer tube **31** are concentric and arranged with radially spaced-apart tube walls. The inner tube **29** forms a central duct **32**; the inner tube **29** and the central tube **30** form an inner annular duct **33**; and the central tube **30** and the outer tube **31** form an outer annular duct **34**. At its closed tube end **35** the inner tube **29** has an inlet **36** for supplying a mixture comprising a carrier gas and coal dust. In the region of its closed end **37** the central tube **30** has an inlet **38** for the supply of oxygen. Finally in the region of its closed end **39** the outer tube **31** has an inlet **40** which is disposed directly at the end of the tube, for the supply of water, and an inlet **42** which is adjacent thereto and which is separated by a separating wall **41**, for the supply of air as the carrier gas.

With that injection lance, coal dust, suspended in a carrier gas, is injected through the central duct **32**, oxygen is injected through the inner annular duct **33** and a spray mist comprising water with air as the carrier gas is injected through the outer annular duct **34**.

The separate supply of the cooling fluid and the oxygen permits mutually independent control of the amounts of those agents which are discharged.

FIG. **6** shows the injection apparatus **10** with the receiving arrangement **12** for receiving the injection lance **11** and **28** respectively.

The receiving arrangement **12** has a connecting region **44** with which it is fitted into a connecting opening **45** in the outside wall **13** of the hot blast conduit **14**. The injection lance **11** or **28** respectively can be inserted in its longitudinal direction into the receiving arrangement **12** and is held in the inserted condition in two receiving bores **46**, **47** in the receiving arrangement **12**. In that connection, the injection lance **11**, **28** is oriented at an acute angle relative to the hot blast flow in the hot blast conduit **14**. In that arrangement, the discharge opening **27**, **43** of the injection lance **11**, **28** is disposed approximately in the region of the centre line of the hot blast flow.

Adjoining the connecting region **44** of the receiving arrangement **12** is a housing portion **48** which is adapted to the contour of the outside wall **13** of the hot blast conduit **14**. The housing portion **48** has a closure means **49** which provides for automatic closure of the receiving bore **46** after removal of the injection lance **11**, **28** from the receiving arrangement **12**.

The closure means **49** comprises a cover-like closing member **50** which is displaceably guided in a guide groove **51** substantially parallel to the outside wall **13** of the hot blast conduit **14**. A compression spring **54** is disposed between the groove bottom which is formed as an abutment **52**, and an end region **53**, which is towards the abutment **52**, of the closing member **50**. The end region of the closing member **50**, which is arranged in opposite relationship to the end region **53** of the closing member **50**, is in the form of a closing edge **55**. As viewed in the direction of displacement of the closing member **50**, arranged in the housing portion **48** is a closing means **56** which is of a configuration which corresponds to the closing edge **55**.

FIG. **6** shows the closing means **49** in the open condition, the closing edge **55** of the closing member **50** being separated from the closing recess **56** by the injection lance **11**, **28**. In that condition the closing member **50** bears under a spring loading against the side of the injection lance **11**, **28**. After removal of the injection lance **11**, **28** from the receiving arrangement **12**, the closing member **50** is displaced by virtue of the force applied thereto by the compression spring **54**, until the closing edge **55** bears in position in the closing recess **56**, whereby the receiving bore **46** of the receiving arrangement **12** is closed and any discharge of gases from the hot blast conduit **14** is prevented.

For the purposes of opening the closure means **49**, the injection lance **11**, **28** is pushed with its discharge openings **27**, **43** against the closing edge **55** of the closing member **50** so that, by utilising the wedge effect, as the closing edge **55** and the longitudinal wall of the injection lance **11**, **28** are disposed at an acute angle to each other, the closing member **50** is displaced towards the abutment **52** against the force of the compression spring **54** and the injection lance **11**, **28** can be moved into a position in which it is ready for operation, in the receiving arrangement **12**.

What is claimed is:

1. A method of cooling an injection lance having a discharge end which extends into a hot blast conduit furnace comprising the steps of

providing said injection lance with at least two tubes, which are concentrically arranged and radially spaced from each other to form a central duct and a first annular duct, each of said tubes being open at said discharge end for injecting material into said hot blast conduit,

injecting a fine grain solid fuel into said hot blast conduit through a first one of said tubes, and

injecting a cooling means, through another of said tubes, for the evaporative cooling of said first one of said tubes.

2. A method according to claim **1**, wherein

said fine grain solid is injected through said central duct, and

said injecting of a cooling means includes injecting a spray mist of water through said first annular duct.

3. A method according to claim **1** including the step of

providing said injection lance with a third tube open at said discharge end for injecting a material into said hot blast conduit, and concentrically arranged with and radially spaced from said other two tubes to thereby form a second annular duct having an annular shape and surrounding said central duct and said first annular duct.

4. A method according to claim **3**, wherein

said fuel is injected through said first duct,

an oxygen-bearing gas is injected through said second duct, and

said cooling means is injected through said third duct.

5. A method according to claim **1** wherein

said injecting of fine grain solid fuel includes mixing an oxygen-bearing gas with a fine grain solid fuel.

6. A method according to claim **1**, wherein

said fine grain solid fuel includes coal dust.

7. An injection apparatus having a discharge end which extends into a hot blast conduit of a blast furnace comprising

at least two tubes which are concentrically arranged and radially spaced from each other to form a central duct and a first annular duct, each of said tubes being open at said discharge end for injecting material into said hot blast conduit,

a first one of said tubes for injecting a fine grain solid fuel into said hot blast conduit, and

another of said tubes for injecting a cooling means for the evaporative cooling of said first one of said tubes.

8. An injection apparatus according to claim 7 wherein

said tubes are removably inserted through an opening in a wall of said hot blast conduit, and further comprising attachment means for attaching said injection apparatus to an outside portion of said wall of said hot blast conduit, and

said attachment means comprises closing means for automatically closing said opening in said wall of said hot blast conduit upon removal of said tube means.

9. An injection apparatus according to claim 7, wherein

said fuel is injected through said central duct, and

said cooling means is a spray mist of water injected through said first annular duct.

10. An injection apparatus according to claim 7, further comprising

a third tube open at said discharge end for injecting material into said hot blast conduit, and being concentrically arranged with and radially spaced from said other tube tubes to thereby form a second annular duct having an annular shape and surrounding said central duct and said first annular duct.

11. An injection apparatus according to claim 7, wherein

said fuel is injected through said central duct,

an oxygen-bearing gas is injected through said first annular duct, and

said cooling means is a spray mist of water injected through said second annular duct.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,403,378
DATED : April 4, 1995
INVENTOR(S) : William Wells and Ralph Weber

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

On the title page, Item [63], Foreign Application Data

Nov. 4, 1991 [DE] Germany.....P4136274.8 -

Signed and Sealed this

Eighteenth Day of June, 1996

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks